EVIDENCE OF GIANT PROTOSTEGID SEA-TURTLES IN THE CRETACEOUS OF NEW JERSEY

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Abstract

An isolated neural plate from the uppermost Mount Laurel Formation (early Maestrichtian, Late Cretaceous) near Hornerstown, Monmouth County, represents the second known occurrence of the family Protostegidae in the Atlantic Coastal Province. It most closely resembles *Protostega* (Turonian to early Campanian) and differs from *Archelon* (Santonian to late Campanian) in lacking a groove on the dorsal midline. The only previous record of an East Coast protostegid is the type specimen of *Pneumatoarthrus peloreus* Cope (1870), consisting of four *Archelon*-like vertebral centra from an unspecified greensand, probably in Monmouth County. These New Jersey finds may represent either an exceptionally late occurrence of *Protostega* or (more probably) a distinct and late-surviving genus of the Protostegidae.

Introduction

Marine turtles of the family Protostegidae, some of which are the largest turtles known from North America, are well represented in the Late Cretaceous sediments of the Western Interior and Gulf Coast. *Protostega*, from which the family takes its name, made its first appearance in the Eagle Ford Shale of Texas (Turonian). Its greatest abundance was in Santonian time, with occurrences in the Brownstone Marl of Arkansas and the Niobrara Chalk of Kansas, and it persisted into early Campanian time in the Mooreville Chalk of Alabama. *Archelon*, the giant of the family, succeeded *Protostega* with some overlap in time: it appeared first in the Niobrara Chalk and ranged upward into the uppermost Pierre Shale of South Dakota and Colorado, which is late Campanian in age (Zangerl, 1953, p. 127).

Until recently, however, protostegid turtles had not been recognized in the Atlantic Coastal Province. A single specimen had been collected as far back as 1859--a series of vertebral centra, probably numbers 5 through 8 of the lumbar series (Figure 1)--but because of their huge size they were originally assumed to belong to some unknown kind of dinosaur. Prof. Edward Drinker Cope of Philadelphia, who named the animal *Pneumatoarthrus peloreus* in 1870, seems to have felt confident of its dinosaurian affinities . . . although he added as an afterthought that "the near resemblance of the bones to those of a tortoise could not be overlooked" (Cope, 1870).

Two years later the first adequate specimen of a protostegid turtle was discovered in the Niobrara Chalk of Kansas and was described by Cope (1872) as a new genus and species, *Protostega gigas*. As happens so often in paleontology, the insights afforded by new material allowed a previous error to be rectified, and Cope reclassified *Pneumatoarthrus* among the sea-turtles. He made the correction so unobtrusively, however, that no other author spotted it; and consequently *Pneumatoarthrus* continued to be listed among the dinosaurs until as recently as 1973 (White). (Cope's policy was to soft-pedal his errors when he couldn't suppress them entirely. He probably suspected that his arch-enemy, Prof. Othniel C. Marsh of Yale, was keeping a notebook on the scientific sins of E. D. Cope.)

A century later I happened upon the type specimen of *Pneumatoarthrus* in the collections of the Academy of Natural Sciences of Philadelphia

The Mosasaur, 2:135-140
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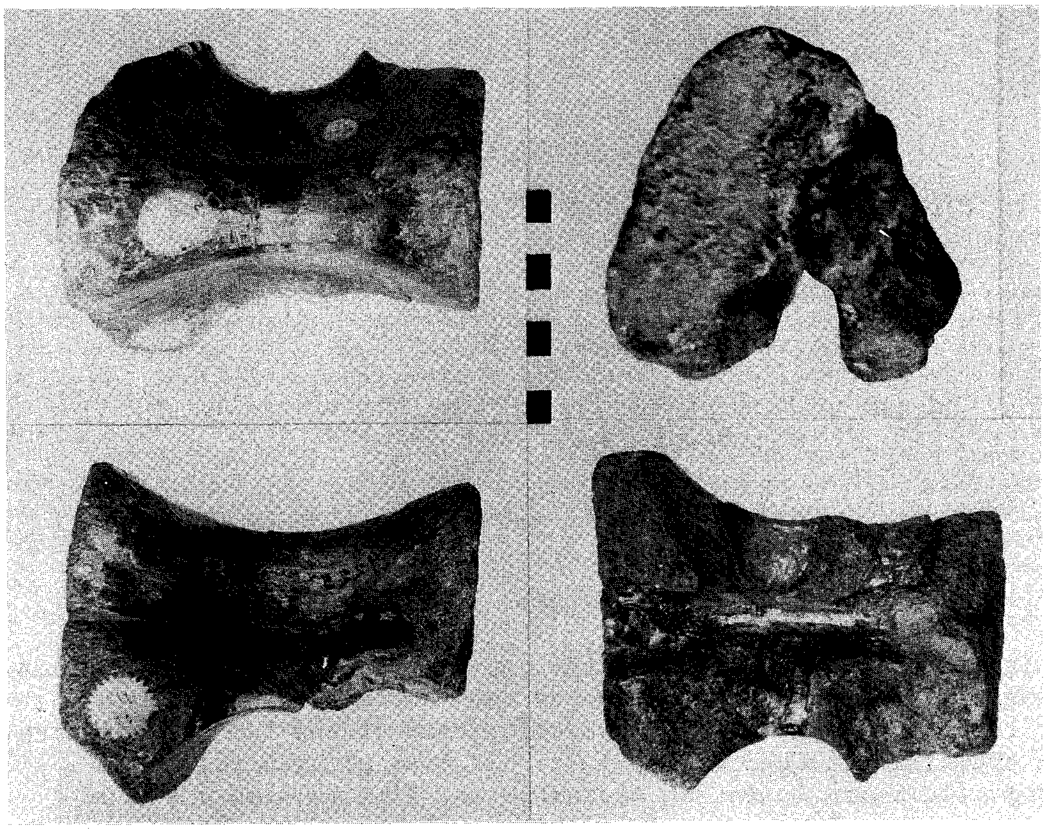

Figure 1

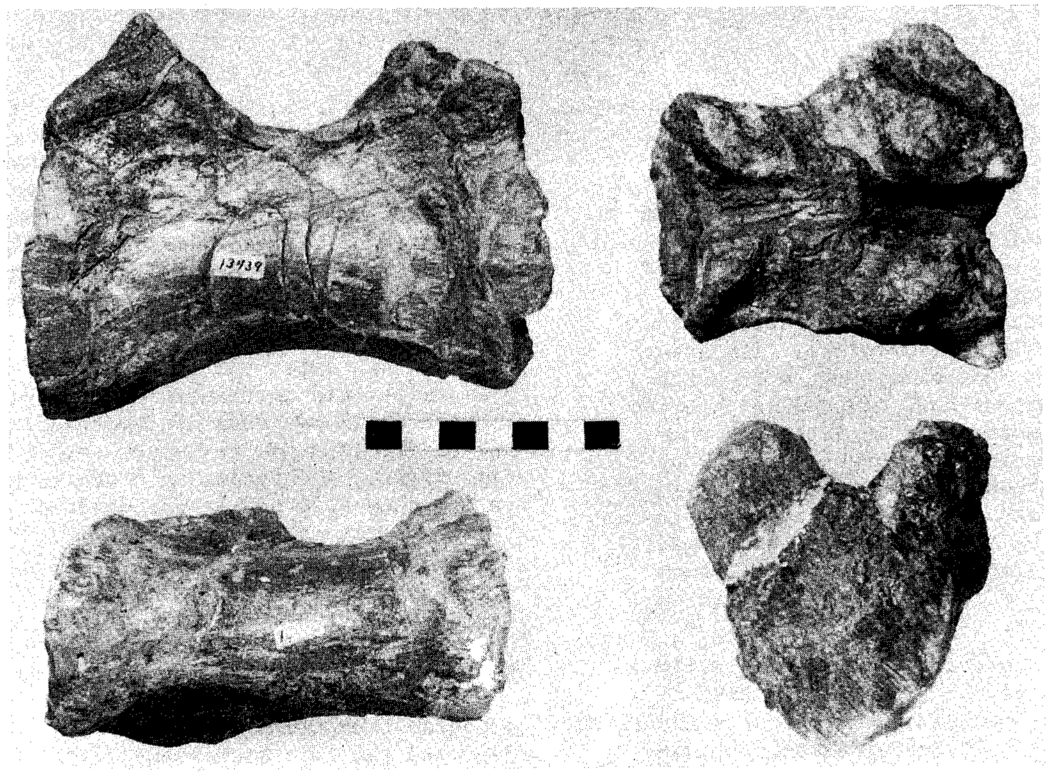

Figure 2

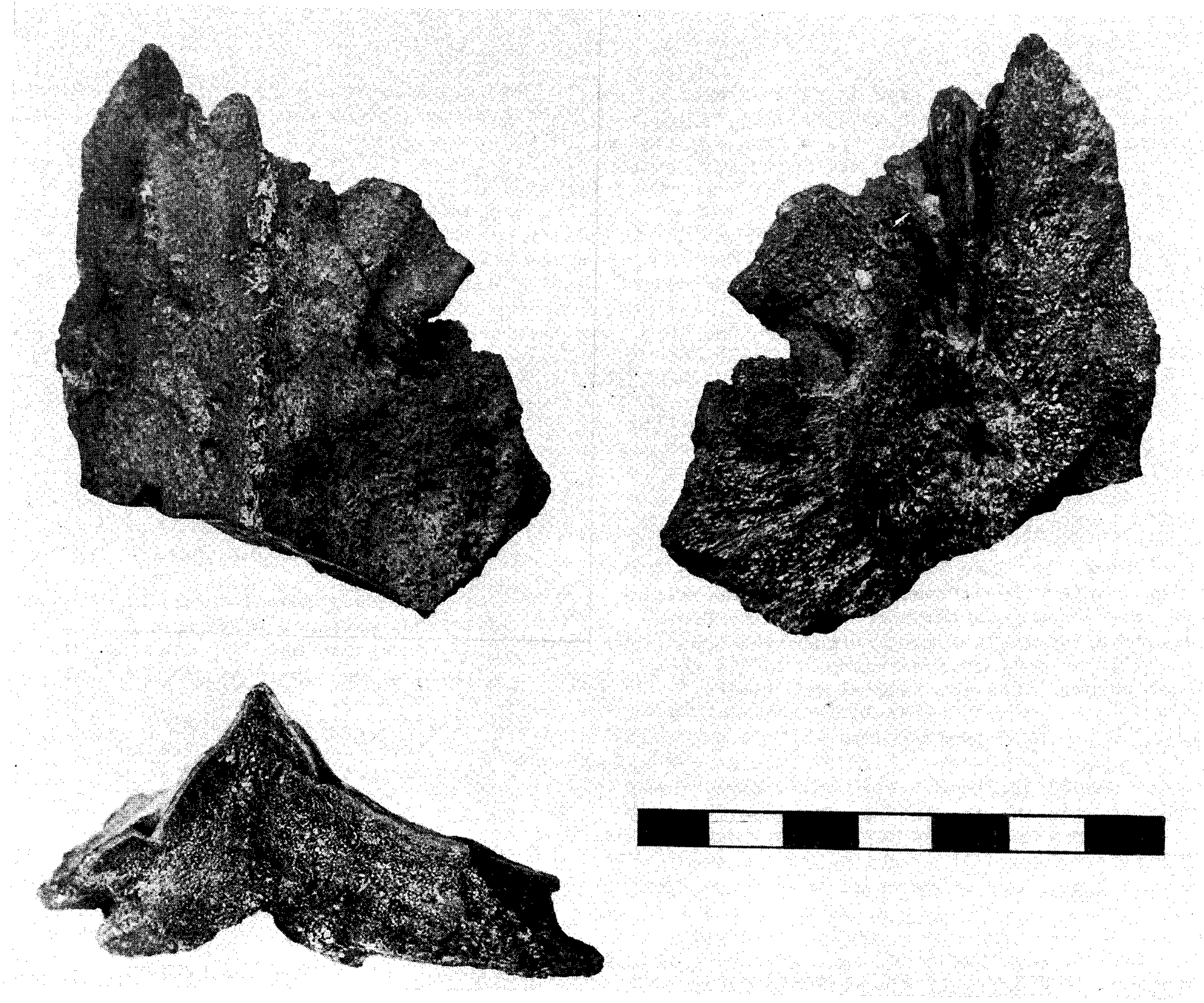

Figure 3

Figure 1. Lumbar vertebral centrum of *Pneumatoarthrus peloreus* Cope from "the greensands of New Jersey," in lateral, dorsal, ventral, and end views. Type specimen, ANSP 9225 in the Academy of Natural Sciences of Philadelphia. Figured by Leidy (1865, pl. XIII, fig. 27-28) as the "supposed sacro-vertebral body of a young *Hadrosaurus*," and by Huene (1932, pl. 3, fig. 3) as the sacral vertebra of *Dryptosaurus aquilunguis* (Cope) (!). Scale in centimeters.

Figure 2. Centra of *Archelon* cf. *A. ischyros* Wieland from the Pierre Shale of Colorado, in lateral, dorsal, ventral, and end views. USNM 13439 in the National Museum of Natural History, Smithsonian Institution (from Baird, 1978, fig. 3). Scale in centimeters.

Figure 3. Protostegid neural plate from the uppermost Mount Laurel Formation of Hornerstown, New Jersey, in dorsal, ventral, and sectional views. PU 23252 in the Museum of Natural History, Princeton University; G. R. Case coll., 1980. Scale in centimeters.

and immediately recognized it as a turtle. In the course of writing up this "discovery" for publication I came across Cope's long-overlooked correction and was both amused and chagrined to find that he had beaten me to it (Baird, 1978).

By comparing Figure 1 with Figure 2, which shows trunk vertebrae of *Archelon* from the Pierre Shale of Colorado, the reader can easily judge for himself the protostegid affinities of *Pneumatoarthrus*. So far as one can tell from the vertebrae these two specimens might belong to the same genus. But turtle vertebrae are not diagnostic at the generic level, and--most unfortunately--the source formation and locality for *Pneumatoarthrus* were never recorded, so all we can say is that it comes from one of the several glauconite-rich marl formations of New Jersey. One of the commercial marl pits in Monmouth County is the most likely source, as the collector, Dr. John H. Slack, was based in Freehold. Under the circumstances it seems safest to refer *Pneumatoarthrus* to the family Protostegidae (where it almost certainly belongs) but leave it as a *genus inquiriendum* in the hope that future finds may clarify the issue.

New Material

A second specimen, also unfortunatly fragmentary, can now be added to the scanty record of the Protostegidae in New Jersey. This bone (PU 23252, Figure 3) is obviously a chelonian neural plate, one of the series of bones that forms the ridgepole of the carapace; and just as obviously it cannot be assigned to any kind of turtle carapace that is currently known from the Cretaceous deposits of the Atlantic Coastal Plain. It was collected in 1980 by Gerard R. Case (who generously donated it to Princeton University) in the spoil from an irrigation pond on the Gray farm, 2 miles west of Hornerstown in Upper Freehold Township, Monmouth County, New Jersey (lat. 40° 07' north, long. 74° 33' west). This site lies west of (across the Walnford-New Egypt Road from) the classic Nutt Farm fossil locality (for which see, *e.g.*, Dorf & Fox, 1957, p. 21). For information on the site and its fauna I am indebted both to Mr. Case and to Ralph Johnson of the Monmouth Amateur Paleontologists Society, who has worked it extensively.

The stratigraphic interval sampled by the bulldozer includes three faunal zones in a thickness of some 2 meters: two in the basal Navesink Formation and one (known as the *Belemnitella* layer) at the top of the underlying Mount Laurel Formation. Matrix preserved in the foramina of the turtle plate is a yellowish-gray sandy clay, indicating that its source is the Mount Laurel rather than the greenish-black, highly glauconitic Navesink. Its age then is early Maestrichtian (Petters, 1976). According to Mr. Johnson (pers. commun.) the *Belemnitella* layer is the chief bone-bearing member in this area and has yielded a number of mosasaur vertebrae and teeth.

The following taxa were collected with the turtle plate (the fish material is preserved in the Case research collection):

Pisces

Squalicorax pristodontus (Agassiz)--crow shark
Ischyrhiza mira Leidy--sawfish
Brachyrhizodus wichitaensis Romer--cow-nose ray
Enchodus ferox Leidy--salmon-like teleost

Arthropoda (Malacostraca)

Protocallianassa mortoni (Pilsbry)
Hoploparia gabbi Pilsbry

Pelecypoda

Pachycardium sp.
Cucullaea antrosa Morton
Crassatellites vadosus (Morton)
Pholas sp.
Pycnodonte [*Gryphaea*] *mutabilis* (Morton)
Dianchora echinata (Morton)
Exogyra costata Say
Exogyra cancellata Stephenson
Inoceramus sp.
Agorostrea falcata (Morton)
Agorostrea mesenterica (Morton)
Plicatula urticosa (Morton)
Pecten venustus Morton
Spondylus gregalis Morton

Gastropoda

Amaurellina sp.

Cephalopoda

Belemnitella americana (Morton)
Baculites ovatus Say
Scaphites sp.

Brachiopoda

Choristothyris plicata Say

Porifera

Cliona microtuberum Stephenson

Description

The neural plate has suffered breakage or erosion on all its edges so that its original dimensions can only be estimated. Its maximum width was originally at least 85 mm and its thickness from the roof of the neural canal to the peak of the dorsal crest is 27 mm. The prominent dorsal ridge, which gives the plate a pagoda-roof appearance in cross-section, is highest over the center of ossification and slopes down toward the anterior and posterior ends. The single axial end that is preserved shows a deeply interdigitated suture for articulation with the next neural in the series. The lateral margins, with which the costal plates articulated, were evidently irregular, with finger-like projections radiating from the center of ossification. The dorsal surface is marked

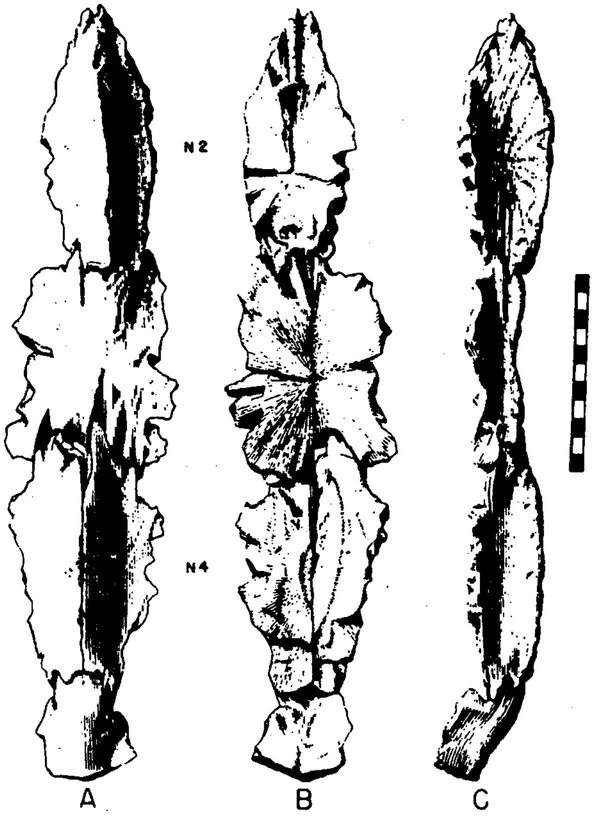

Figure 4. Articulated neural plates 2 through 5 of *Protostega dixie* Zangerl from the Selma Formation (Mooreville Chalk) of Alabama, in (*A*) dorsal, (*B*) ventral, and (*C*) lateral views. Type specimen, P27314 in the Field Museum of Natural History (from Zangerl, 1953, fig. 25). Scale in centimeters.

with a scattering of conical pits, 2 to 3 mm in diameter, that funnel into vascular canals. The ventral surface reveals the roof of the neural canal, from which the vascular canals radiate into the substance of the bone; this is flanked by a pair of semilunar buttresses that served for attachment to the neural-arch pedicels of the underlying vertebra.

The situation of this neural plate can be visualized by reference to Figure 4, which shows part of the neural series of *Protostega dixie* from the Selma Formation (Mooreville Chalk) of Alabama, and Figure 5, a restored skeleton of *Archelon ischyros* from the Pierre Shale of South Dakota.

Comparisons

Its deeply-digitated lateral margins and pagoda-roof cross-section eliminate all Cretaceous turtles except the Protostegidae from comparison with the neural plate from Hornerstown. The protostegid genus that comes closest to it in age is *Archelon*, which ranged into late Campanian time. However, according to Wieland (1903, 1909) the crested neurals of *Archelon* are marked by a conspicuous groove or slot on the dorsal midline. *Protostega*, which lacks such a groove, is much more similar to PU 23252. The temporal range of *Protostega*, however, is from Turonian to early Campanian and its latest known occurrence is thus conspicuously earlier than that of the Hornerstown specimen. The other two genera of protostegids, *Chelosphargis* and *Calcarichelys* (Zangerl, 1953), have non-digitated neural plates and thus require no discussion.

The fragmentary specimen from Hornerstown, then, appears to represent either a remarkably late survival of *Protostega* or (more probably) a distinct and late-surviving genus of the Protostegidae. Of course no comparison can be made between it and the vertebrae that constitute the type specimen of *Pneumatoarthrus peloreus*, and the age of the latter taxon is uncertain although a Maestrichtian dating is the most likely (Baird, 1978). Only future finds will enable us to decide whether these two finds represent the same animal, and, if so, to determine its relationships within the family Protostegidae. In any case it is clear that the turtles of this group were relatively rare in the pelagic herpetofauna of the Atlantic Coast in late Cretaceous time.

Acknowledgements

We are indebted to Gerard R. Case for discovering and donating the new specimen and to Ralph Johnson of the Monmouth Amateur Paleontologists Society for additional information on the site and associated fauna. Curatorial staffs of the Academy of Natural Sciences of Philadelphia and the National Museum of Natural History kindly made available the other specimens illustrated. This research was supported by the William Berryman Scott Fund of Princeton University.

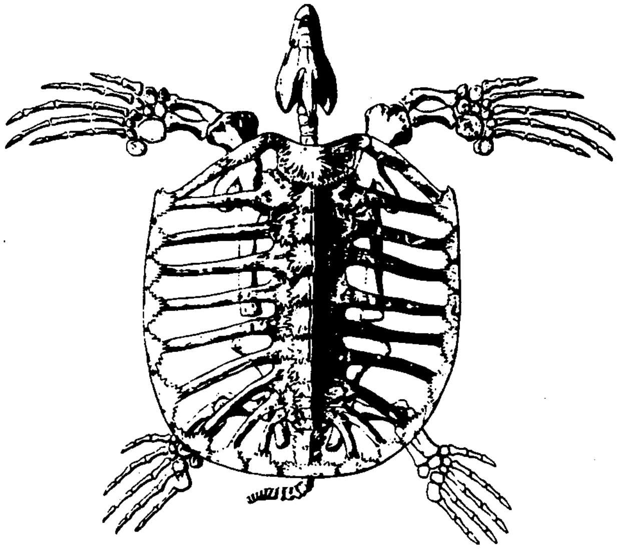

Figure 5. Restored skeleton of *Archelon ischyros* Wieland from the Pierre Shale of South Dakota. Type specimen in the Peabody Museum of Natural History, Yale University (from Wieland, 1909, fig. 7). Maximum length of carapace is 193 cm (6.3 feet).

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